City of Seattle
Department of Design, Construction and Land Use
CLIENT ASSISTANCE MEMO

412

Residential (Group R Occupancy) Energy Code Compliance Using the WATTSUN Program

March 1999

OVERVIEW

There are three paths for Energy Code compliance for residential spaces: Prescriptive (Chapter 6), Target UA (Chapter 5), and Energy Budget (Chapter 4). The Prescriptive approach is the simplest and may be used to demonstrate compliance regardless of how complex the design process may have been. However, this approach has the least flexibility.

For cases where the project does not comply with the Prescriptive approach, the designer may wish to consider the Target UA or Energy Budget approaches. While these approaches are more complex, they do offer more flexibility. The WATTSUN Program calculates performance in accordance with both the Target UA and Energy Budget approaches. *Compliance must be demonstrated using Version 5.6, previous versions are not acceptable.*

WATTSUN 5.6 is available for $200 from:

Washington State University
Cooperative Extension Energy Program
P.O. Box 43165
Olympia, WA 98504
(360) 956-2031
www.energy.wsu.edu/software/WATTSUN/wat4.htm

Contact the WSU Energy Program for any questions on computer hardware requirements.

What you *CAN* do with WATTSUN 5.6

WATTSUN can be used to demonstrate Energy Code compliance for residential spaces (Group R Occupancy) under either the Target UA (Section 502.2) or the Systems Analysis (Section 402) options.

WATTSUN allows tradeoffs between various elements of the building envelope. For instance, credit can be taken for more insulation (higher R-value) or better windows (lower U-factor) to offset under-insulated components or increased glazing area.

WATTSUN allows credit for improvements in heating system efficiency for fossil fuel and for heat pumps (AFUE or HSPF).

What you *CANNOT* do with WATTSUN 5.6

WATTSUN cannot be used for any nonresidential spaces.

WATTSUN cannot be used to take credit for cooling system efficiencies.

WATTSUN cannot be used to show improvements to existing residential spaces.

GUIDELINES FOR USE OF THE WATTSUN PROGRAM

The information below follows the order of the WATTSUN 5.6 input screens. The first grouping used by the program is titled QUALIFY: Energy Code, Heating System, Ducts, Component Performance, and Solar. The second grouping is HVAC: Ventilation, Sizing, Cooling, and Weather. The third grouping is ADDRESS: Site and Jurisdiction. The fourth grouping is ECONOMICS. The fifth grouping is LIBRARY.

QUALIFY—Energy Code

House type: Select appropriate type.

# of dwelling units (multifamily only): Enter value to match drawings.

# of bedrooms/unit: Enter value to match drawings.

Total heated floor area: Enter heated floor area to match drawings, do not include garage or unheated basements or attic area. (See “conditioned space” definition in Energy Code Section 201.1.)

Reference Code for electric fuel: Select "1997 WA State Energy Code".

Reference Code for other fuel types: Select "1997 WA State Energy Code".

Solar access characteristics: Select "Shaded," unless "Partially Shaded" or "Unshaded w/ solar access" is justified by the use of a sun chart (see CAM 417 for a blank sun chart and guidance on how to complete it). Note that "Partially Shaded" means that sunlight reaches the building and, in particular, the fenestration (windows, glazed doors, and skylights) for 75% of the hours between 9 a.m. and 3 p.m. solar time on December 21 (i.e., that the building is shaded by trees, buildings or other external conditions for not more than one and a half of the six hours between 9 a.m. and 3 p.m.). "Unshaded with Solar Access" implies that sunlight can reach the building for all six of the hours on December 21 and that there is a solar access agreement to guarantee that the building will remain unshaded.

Wood burning appliance: Does not affect outcome.

Comparison house: Not necessary.

QUALIFY—Heating System

Heating system: Select system type to match drawings. (The space heating system type must be noted on the drawings.)

Make/model #: Select “default” unless credit is being claimed for a higher efficiency unit. (If credit is claimed, this information must be noted on the drawings.)

QUALIFY—Ducts

Supply ducts location: Select appropriate location for majority of ducts.

Supply ducts total surface area: Use default area calculated by program, unless ductwork is shown on drawings and a value is entered to match drawings.

Supply ducts average R-value: Enter value to match drawings.

Return ducts location: Select appropriate location for majority of ducts.

Return ducts total surface area: Use default area calculated by program, unless ductwork is shown on drawings and a value is entered to match drawings.

Return ducts average R-value: Enter value to match drawings.

QUALIFY—Component Performance

Use the following hierarchy to determine U-factors for each component:

FIRST: To the extent possible, assembly descriptions are to be selected from the WATTSUN lists for each component.
SECOND: Please note, however, that the assembly descriptions in the WATTSUN lists do NOT include all of the assemblies included in Chapter 10 of the Energy Code. WHEREVER ASSEMBLIES ARE INCLUDED IN CHAPTER 10, THE CORRESPONDING DEFAULT U-FACTORS ARE TO BE USED. In this case, select "OTHER" and then, under description, enter the insulation R-value followed by the assembly type and the Energy Code table number that this default is taken from; then enter U-factor.
THIRD: For variations of assemblies, use the AutoCalc feature. Select "Library", then select "Site-built Components", then select the appropriate "Component", then press "F9" for more, then press "F7" for AutoCalc. Complete the inputs and press "F10" to save.
FOURTH: If the U-factor cannot be determined using any of the previous methods, then follow the procedures in RS-1, the ASHRAE 1997 Handbook of Fundamentals, using the assumptions in Chapter 10 of the Energy Code.

Below grade walls: Select description from list to match drawings. Enter area of below grade wall and lineal feet of perimeter of below grade slab (i.e., basement floor) to match drawings.

Slab on grade: Select description from list to match drawings. Enter lineal feet of perimeter to match drawings.

Floor: Select description from list to match drawings. Enter area. CHAPTER 10 OF THE ENERGY CODE DOES HAVE DEFAULT U-FACTORS FOR EXPOSED FLOORS IN TABLE 10-4A WHICH ARE TO BE USED (even though they are not included in the WATTSUN floor list).

Window: Select descriptions from list to match drawings. To take credit for NFRC certified products, select "OTHER" and then, under description, enter "NFRC" followed by the number of glazing layers, frame type, gap width, low-e, and gas fill as appropriate (in the same format as the descriptions for the defaults). Enter the U-factor. It is not necessary to enter costs. Enter areas using rough opening areas to match drawings.

Doors: Select descriptions from list to match drawings. Be sure to select descriptions having "wood w/NFRC Label" to take credit for NFRC values. Enter the U-factor. It is not necessary to enter costs. Enter areas using rough opening areas to match drawings.

Above grade wall: Select description from list to match drawings. Enter area using net opaque area (gross wall area minus glazing and doors) to match drawings. CHAPTER 10 OF THE ENERGY CODE DOES HAVE A MORE COMPLETE SET OF DEFAULT U-FACTORS FOR METAL STUD WALLS IN TABLE 10-5A WHICH ARE TO BE USED (even though they are not all included in the WATTSUN wall list).

Skylights: Select descriptions from list to match drawings. To take credit for NFRC certified products, select "OTHER" and then, under description, enter "NFRC" followed by the number of glazing layers, frame type, gap width, low-e, and gas fill as appropriate (in the same format as the descriptions for the defaults). Enter the U-factor. It is not necessary to enter costs. Enter areas using rough opening areas to match drawings.

Ceiling: Select description from list to match drawings. Enter area using net opaque area (gross roof area minus skylights) to match drawings. CHAPTER 10 OF THE ENERGY CODE DOES HAVE DEFAULT U-FACTORS FOR STEEL STRUSS CEILINGS IN TABLES 10-7A TO 10-7E WHICH ARE TO BE USED (even though they are not included in the WATTSUN ceiling list).

Infiltration: Select "Standard Air Sealing" (no credit is given for infiltration measures). Enter volume of conditioned space.

Structural mass: Select description from list to match drawings. "Slab w/No cover" is <u>not</u> acceptable unless concrete slab is covered with tile or some decorative surface. (Otherwise, it is presumed that occupants will cover the slab with carpeting.) No credit is given for mass in the basement unless there are windows to provide direct solar radiation to this mass.

Additional mass: This category is only for materials <u>in addition to</u> those already included in the structural mass category. (If values are input, provide calculations to justify.)

QUALIFY—Solar

Direction: Select description from list to match drawings.

Area: Enter value to match drawings for each direction.

Glz Type: Select description from list to match drawings. Use "2Gl Heat Absorbing" for glazing with a low-emissivity coating.

Moveable Shading: Select description from list to match drawings. "No shading" is acceptable.

Multiplier: Generally leave as is.

HVAC—Ventilation

Ventilation type: Select appropriate type.

Option: Select appropriate type.

HVAC—Sizing

Heating system size (% of load): Enter 100-200%. (100% is minimum per Building Code, 200% is maximum per Energy Code for Group R occupancy, Section 503.2.2.)

Winter design ACH: Enter 0.35-0.60. (Up to 0.60 is acceptable for sizing screen only.)

Thermostat setpoint (F): Enter 70. (Up to 70 is acceptable for heating sizing per Energy Code, Section 302.2.1. Annual energy analysis assumes setback.)

Cooling system size (% of load): Enter 0-200%. (There is no Building Code minimum, 200% is maximum per Energy Code for Group R occupancy, Section 503.2.2.)

Thermostat setpoint (F): Enter 78 (per Energy Code Section 302.2.1).

HVAC—Cooling

Cooling system: Enter make and model number (if cooling is provided).

SEER: Enter value to match drawings.

Delivery: Select appropriate type.

HVAC—Weather

Weather file: Select "Seattle, WA"

Zone: Leave as "1"

Winter outdoor design temp: Either use the weather file default of "26 °F" or modify to use the Seattle value of "24 °F." (Modifying to 24 °F will result in a slightly higher load thereby allowing a slightly larger equipment size.)

Summer outdoor design temp: Leave as "82 °"

Summer average daily temp range: Leave as "22 °"

Yearly average temp: Leave as "51.4 °"

Latitude: Leave as "47.5 °"

Elevation: Either use the weather file default of "385" feet or modify to use a more accurate value for the site.

ADDRESS—Site

These fields contain information that can be useful during plan review or inspection. A number of these fields (but not all of them) are printed on the first page of the "Compliance Documentation" report. Please follow the recommendations below so that useful information is printed in the "Compliance Documentation" report. In particular, (1) to correlate the analysis with the plans submitted for a permit, please provide the DCLU address in the site "street address" field and (2) to make contacts easier, please provide the name of the person who did the WATTSUN analysis and contact information in the "homeowner" fields.

Site house ID: Enter description that can be used to distinguish this run from another variant done for the same project. (This ends up in the heading for each page of the "Compliance Documentation" report.)

Site street address: Enter the DCLU address used in the building permit application. (This field is printed on the first page of the "Compliance Documentation" report.)

Site city: Enter "Seattle". (This field is printed on the first page of the "Compliance Documentation" report.)

Site state: Enter "WA". (This field is printed on the first page of the "Compliance Documentation" report.)

Site zip: Enter appropriate zipcode. (This field is printed on the first page of the "Compliance Documentation" report.)

Onsite phone: Optional. (This field is printed on the first page of the "Compliance Documentation" report.)

Builder contact: Optional (not printed).

Builder company: Optional. (This field is printed on the first page of the "Compliance Documentation" report.)

Builder mail address: Optional. (This field is printed on the first page of the "Compliance Documentation" report.)

Builder city: Optional (not printed).

Builder state: Optional (not printed).

Builder zip: Optional (not printed).

Builder phone: Optional. (This field is printed on the first page of the "Compliance Documentation" report.)

Homeowner name: Enter name of the person who did the WATTSUN analysis and can answer questions about the analysis AND the name of the company, if it will fit in this field. (This field is printed on the first page of the "Compliance Documentation" report.)

Homeowner current address: Enter the street address of the person who did the WATTSUN analysis. (This field is printed on the first page of the "Compliance Documentation" report.)

Homeowner city: Optional (not printed).

Homeowner state: Optional (not printed).

Homeowner zip: Optional (not printed).

Homeowner phone: Enter the phone number of the person who did the WATTSUN analysis. (This field is printed on the first page of the "Compliance Documentation" report.)

UTILITY—Jurisdiction

No entries necessary.

ECONOMICS

No entries necessary.

LIBRARY

See discussion under "QUALIFY - Component Performance" for when to add entries to library and recommended format to use for entries.

COMPLIANCE DETERMINATION

The program provides the results for both the Component Performance (Target UA) and the Energy Budget compliance options. Determine whether the project complies using the Component Performance or the Energy Budget option.

Component Performance (Target UA)

For Component Performance, check to see whether the output shows that the Proposed UA is lower than the Reference (Target) UA. If so, then the project complies using the Component Performance option. In this case, submit the necessary documentation as described below. It is not necessary to evaluate the Energy Budget.

Energy Budget

If the Proposed UA is higher than the Reference (Target) UA, but the program says "QUALIFIES for 1997 WA State Energy Code", it indicates that the project could comply using the Energy Budget option. HOWEVER, IT IS POSSIBLE THAT THE PROJECT STILL DOES NOT COMPLY. It is also necessary to do a separate hand calculation to check the mass requirements as described in the following paragraph.

Section 402.1.4 has additional requirements for mass if the effective south glazing area (the south-facing glazing, plus a percentage of glazing facing other orientations) is 8% or more of the floor area. These requirements are in the code so that passive solar credit is given for buildings which will perform as passive solar structures and not overheat. The WATTSUN program automatically calculates effective south glazing. If the effective south glazing (*Eff S Glz* under *GLAZING ORIENTATION*) is 8.0 % or more, then verify that the building contains 45 Btu/°F of mass for each square foot of south facing equivalent glazing (Section 402.1.4).

Minimum mass required = (*Eff S Glz %*/100) x Heated floor area x 45

The structural mass provided *(Struc Mass)* is indicated in the Compliance Report.

When required minimum mass is provided, print the "Compliance Documentation" Report and submit it with the necessary documentation.

DOCUMENTATION TO BE SUBMITTED

Provide plans to fully reflect elements detailed in WATTSUN.

Provide NFRC certified glazing and door U-factors to match inputs or note such on window and opaque door schedule. (This is not necessary if one of the defaults from Energy Code section 1006 has been used, but drawings must indicate U-factors.)

Provide R-values of insulation on drawings of building sections to match inputs for roof, above grade wall, below grade wall, floor, slab on grade floor, basement floor.

User components that are not listed in the default tables will be designated **. If any entries have **, provide calculations to justify user input U-factors for opaque envelope assemblies.

Provide calculations for mass.

If site solar exposure is claimed as partially shaded or unshaded, provide sun chart to justify. (This is not necessary if shaded is input.) See CAM 417 for a blank sun chart and guidance on how to complete it.

Provide note on drawing indicating heating equipment AFUE or HSPF. (This is not necessary if credit has not been taken for improved equipment efficiency.)

Review Checklist

1. Verify that the space heating system type modeled matches the drawings. Assume electric resistance unless the drawings indicated otherwise.
2. Verify that all spaces have been modeled. Assume that all spaces are conditioned (except for garages) unless otherwise agreed by the building official.
3. Verify that areas input match the drawings.
   - For glazing and opaque doors, make sure that take-offs are done using the rough opening areas. Make sure that the calculations include all glazing, such as garden windows and skylights, and all opaque doors, such as those from conditioned space into a garage.
   - For roof/ceilings, make sure that all roof types are modeled.
   - For walls, make sure that the perimeter edges of intermediate floors are modeled separately if insulated differently.

- For floors, make sure that uninsulated floor areas, due to columns or beams, are modeled separately.

4. Verify glazing and door schedules for vertical glazing, overhead glazing, and opaque doors. Make sure that the schedule includes manufacturer and model number for all products with U-factor below 0.40, indicates NFRC certified U-factors where applicable and indicates energy efficiency features where defaults are being used so that these can be verified by the field inspector.
5. Verify insulation R-values on all sections:
   - For ceilings, insulation in the attic and sloped ceilings.
   - For walls, cavity insulation and/or continuous insulated sheathing, the perimeter edges of intermediate floors, basement walls.
   - For floors, insulation around beams.
6. Review all the items with double asterisks (**) in the WATTSUN "Compliance Documentation" report. Documentation must be provided for all components which don't use the WATTSUN lists. Verify that documentation is acceptable. Review AutoCalc screens, if applicable
7. If complying using the Energy Budget option, determine what the solar access claimed is. If input is "partially shaded" or "unshaded", verify that sunchart is submitted and justifies the solar access input.
8. If complying using the Energy Budget option, determine whether the effective south facing glazing area is 8.0% or greater. If so, verify that adequate thermal mass is provided to comply Energy Code Section 402.1.4.

   If complying using the Energy Budget option, determine whether credit is being taken for high efficiency space heating equipment. If so, verify that this information is on the drawings.

ADDITIONAL INFORMATION

For additional copies of this Client Assistance Memo or revised versions of it, contact Seattle DCLU at (206) 684-8850. All Client Assistance Memos are public domain documents and may be freely copied without any special permission.

For projects within the Seattle city limits, further information on the Seattle Energy Code requirements is available from the DCLU Energy Technical Backup line at (206) 684-7846 from1:00-4:15 p.m. Or visit the Energy Code website at www.cityofseattle.net/dclu/energy.

EXAMPLE

The schematic design for a proposed multifamily building does not comply using any of the Prescriptive options (Chapter 6). Determine whether it complies using either the Component Performance (Chapter 5) or Systems Analysis (Chapter 4) options.

PROJECT SPECIFICATIONS

The specifications of the proposed design are as follows:

Building shape: 120 feet long x 40 feet deep with a north-south axis, the total height of the three conditioned floors is 24 feet, there are no overhangs over the windows

Number of stories: four story (three stories of dwelling units over a parking level)

Number of units: 18 unit (with an average of 3 bedrooms per unit)

Building construction: metal roof trusses, metal framed walls inset between concrete floors, concrete floors (both intermediate and bottom floor)

Space heating and cooling system type: gas space heat, direct-ducted through-the-wall in each unit; no space cooling

Glazing: 400 square feet of sliding windows on the north, 510 square feet of sliding windows and 90 square feet of garden windows on the south, 1440 square feet of sliding windows and 360 square feet of sliding doors on the east and also on the west, and 48 square feet of skylights; the fenestration products are all double-glazing with a 0.10 low-emissivity coating and a ½ inch gap filled with argon gas and having an insulated spacer in a vinyl frame; the sliding windows are NFRC certified U-0.33, the sliding doors are NFRC certified U-0.35, the garden windows and the skylights are not NFRC certified

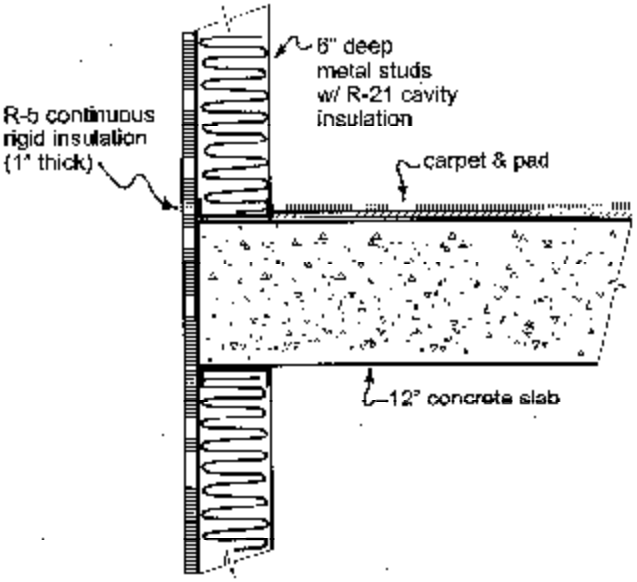
Opaque door: 60 square feet of opaque insulated metal door with a thermal break in the slab and in the frame, the opaque doors are NFRC certified U-0.14

Roof: R-49 insulation in an attic with steel trusses

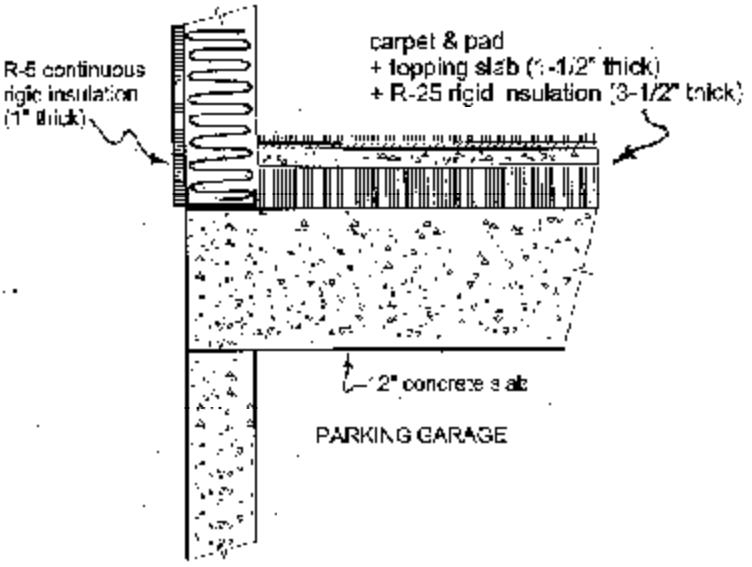
Wall: R-21 cavity insulation and R-5 continuous insulated sheathing over 2 x 6 metal framing @16 inch on center, and R-5 rigid insulation on the perimeter of the 12 inch thick concrete slabs on intermediate floors

Floors: R-25 insulation ABOVE the slab covered with a topping slab on the bottom floor over the parking garage, except for 10% of the floor area where metal channels are connected directly to the concrete floor as the base plate for interior partition walls

INTERMEDIATE FLOOR SECTION
Scale: 1" = 1'0"



LOWER FLOOR SECTION
(Insulation Above Slab)
Scale: 1" = 1'0"



WATTSUN INPUTS FOR EXAMPLE BUILDING

QUALIFY—Energy Code

House type: Select "Multi-family".

 # Dwelling units: Input "18".

 # Bedrooms/unit: Input "3".

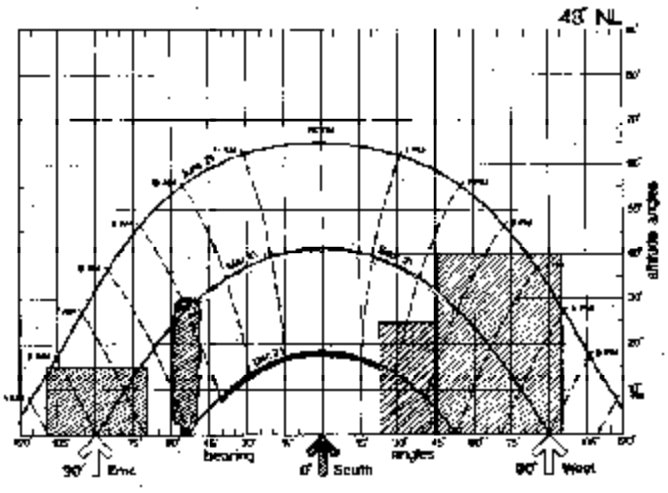
Total heated floor area: Input "14,400" (40' x 120' x 3 stories).

Reference code (electric heat): Select "1997 WA State Energy Code".

Reference code (other fuels): Select "1997 WA State Energy Code".

Solar access: Determine the amount of sunlight that strikes the building between 9 am and 3 pm solar time on December 21st. Using a sun chart for 48 degrees latitude, mark the times when the building is shaded. The attached sun chart indicates that the building is shaded for 1-1/2 hours of the 6 hours between 9 am and 3 pm on December 21st. Therefore (referring to the guidelines in the beginning of this Client Assistance Memo), select "Partially Shaded".

SUN CHART FOR THE BUILDING SITE



Wood-burning appliance: Select "No".

Comparison house: Select "No".

QUALIFY—Heating System

Heating system: Select "Gas Furnace".

Make/Model#: Select "DEFAULT", as there is no proposal here to take credit for higher efficiency. (If credit was to be taken, the model number and efficiency would need to be indicated on the drawings.)

AFUE: Do not modify the "78%", as this is the code minimum.

QUALIFY—Ducts

Supply ducts - Location: Select "All in heated space".

Supply ducts - Total surface area: Leave as "0.0", as all heat loss is presumed to stay within the heated space.

Supply ducts - Average Rvalue: Leave as "0.0", as all heat loss is presumed to stay within the heated space.

Return ducts - Location: Select "All in heated space".

Return ducts - Total surface area: Leave as "0.0", as all heat loss is presumed to stay within the heated space.

Return ducts - Average Rvalue: Leave as "0.0", as all heat loss is presumed to stay within the heated space.

QUALIFY—Component Performance

Below grade wall: No entries.

Slab on grade: No entries.

Floor: There are two floor types to be input: one for the insulated portion and one for the uninsulated portion.

For the insulated portion of the floor, CHAPTER 10 DOES HAVE DEFAULT U-FACTORS FOR EXPOSED CONCRETE FLOORS IN TABLE 10-4A WHICH ARE TO BE USED (even though they are not included in the WATTSUN floor list). Referring to Chapter 10, Table 10-4A, use the value for R-25 insulation for concrete. Add this assembly description and U-factor (U-0.037) to the floor list. Use this assembly for 90% of the floor area. The insulated area is 120 x 40 x 90% = 4,380 square feet.

For the other 10% of the floor which is uninsulated, calculate the U-factor for a 12 inch concrete floor. The resistances are:

- R-0.17 for the exterior air film (Chapter 5, Equation 2)

- R-0.96 for the concrete = 0.08/inch x 12 inch floor thickness (Standard RS-1, ASHRAE 1997 Handbook of Fundamentals, Chapter 24, Table 4, Masonry Materials, Concretes, interpolated for standard weight aggregate of 144 lbs/ft^3, using the midpoint of the resulting 0.105-0.055 range)
- R-0.92 for the interior horizontal air film (Chapter 5, Equation 2).

The total resistance is 2.05 (= 0.17 + 0.96 + 0.92), resulting in a U-factor of 0.488. The uninsulated area is 120 x 40 x 10% = 480 square feet.

(Note: If the insulation was below the floor, there would also be a certain percentage of the floor that was uninsulated due to structural columns or supporting walls below.)

Window: There are three types of vertical fenestration to be input: sliding windows, sliding doors, and garden windows.

For the sliding windows, insert a new entry into the WATTSUN window list for NFRC certified U-0.33 (NFRC Vin/LoE-0.10/Ar/Ins.sp. Sl.win). The area is 3,790 square feet (400 + 510 +1440 +1440).

For the sliding glass doors, insert a new entry into the WATTSUN window list for NFRC certified U-0.35 (NFRC Vin/LoE-0.10/Ar/Ins.sp. Sl.dr). The area is 720 square feet (360 + 360).

For the garden windows, select the appropriate description and default U-factor (U-1.47) in the WATTSUN window list (2gl wd/vin Ar + LoE Garden—third to last). The area is 90 square feet.

Door: There is one opaque door type to be input: opaque metal door.

For the metal doors, insert a new entry into the WATTSUN door list for NFRC certified U-0.14. The area is 60 square feet.

Above grade wall: There are two wall types to be input: the metal framed portion of the wall and the peripheral edges of intermediate floor portion of the wall.

For the metal stud portion of the wall, CHAPTER 10 DOES HAVE DEFAULT U-FACTORS FOR R-21 METAL STUD WALLS IN TABLE 10-5A WHICH ARE TO BE USED (even though they are not included in the WATTSUN floor list). Referring to Chapter 10, Table 10-5A, use the value for metal framing at 16" on center with R-21 cavity insulation plus R-5 sheathing. Add this assembly description and U-factor (U-0.065) to the wall list. Use this assembly for metal stud wall area between the concrete floor slabs. The metal stud wall area is 2,380 square feet - which is the gross wall area of 7,680 square feet ((120 + 40 + 120 + 40) x 24) minus the vertical glazing area of 4,600 square feet (400 + 510 + 90 + 1440 + 360 + 1440 + 360) minus the opaque door area of 60 square feet minus the perimeter edge of intermediate floor area of 640 square feet ((120 + 40 + 120 + 40) x 1 x 2).

For the peripheral edges of intermediate floor portion of the wall, calculate the U-factor the 5 inch width of the peripheral edge of the intermediate concrete floor which is under the metal stud wall. The resistances are:

- R-0.17 for the exterior air film (Chapter 5, Equation 2)
- R-5.00 for the continuous insulation
- R-0.40 for the concrete under the metal stud wall = 0.08/inch x 5 inches width of metal stud wall (see reference for the previous floor entry)
- R-0.68 for the interior horizontal air film (Chapter 5, Equation 2).

The total resistance is 6.25, resulting in a U-factor of 0.160. The peripheral edge of intermediate floor area is 640 square feet ((120 + 40 + 120 + 40 linear feet of perimeter) x 1 foot thick concrete slab x 2 intermediate floors).

Skylight: There is one skylight type to be input: vinyl-framed skylight.

For the skylight, select the appropriate description and default U-factor (U-0.52) in the WATTSUN skylight list (2gl Wd/V-clad Wd/V LoE .1+Ar). The area is 48 square feet.

Ceiling: There is one ceiling type to be input: steel truss framed ceiling.

For the ceiling, CHAPTER 10 DOES HAVE DEFAULT U-FACTORS FOR STEEL TRUSS FRAMED CEILINGS IN TABLES 10-7A TO 10-7E WHICH ARE TO BE USED (even though they are not included in the WATTSUN ceiling list). Referring to Chapter 10, Table 10-7A (because the ceiling in this project does not have any sheathing), use the value for R-49 insulation at the 36 foot truss span (as this is the closest to the 40 feet span in the proposed building). Add this assembly description and U-factor (U-0.040) to the list. The opaque ceiling area is 4,752 square feet - which is 4,800 square feet of gross area (40 x 120) minus 48 square feet of skylight area.

Infiltration: Select "Standard Air Sealing" and input the volume of the building which is 115,200 cubic feet (40 x 120 x 24).

Structural Mass: There are two structural mass types to be input: one for the upper two floors where the mass of the concrete floor is within the insulated shell and one for the lower floor where the mass of the concrete floor is outside the insulated shell. For the upper two floors where the mass of the concrete floor is within the insulated shell, select "Slab w/carpet w/pad, Sheetrock wall". The area is 9,600 square feet (40 x 120 x 2 floors).

For the lower floor where the mass of the concrete floor is outside the insulated shell, select "Light Frame, Sheetrock wall". The area is 4,800 square feet (40 x 120 x 1 floor).

QUALIFY—Solar

Direction: Select "South", "East", "North", "West", "Skylights", and then enter values to match drawings.

Area: Enter "600" (510 + 90) for south, "1800" (1440 + 360) for east, "400" for north, "1800" (1440 + 360) for west, and "96" for skylights.

Glz Type: Select "2 Gl Heat Absorbing", as the glazing has a low-emissivity coating.

Moveable Shading: Select "No Shading".

Multiplier: Leave as is.

COMPLIANCE DETERMINATION

The "Compliance Documentation" report for this example is attached. The output provides the results for both the Component Performance (Target UA) and the Energy Budget compliance options.

Component Performance (Target UA)

For Component Performance, the output shows that the Proposed UA of 2512 is higher (17% higher) than the Reference (Target) UA of 2141. Consequently, the project does not comply using the Component Performance option. However, reviewing this output and comparing the proposed design with the reference design is recommended as it does provide some insights.

For the proposed floor, the heat loss (UA) through the 10% of the floor that is uninsulated (234.2) is greater than that through the 90% of the floor that is insulated (162.1). The total heat loss through the proposed floor (162.1 + 234.2 = 396.3) is double that of the reference floor (199.3).

The vertical glazing (sliding windows, sliding glass doors, and garden windows) is the largest source of heat loss, more significant than all of the opaque elements together, for both the proposed and the reference design. Even with the better windows, the total heat loss through the proposed vertical glazing (1250.7 + 252.0 + 132.3 = 1635.0) is well above that of the reference vertical glazing (1372.8), accounting for the majority of the overage in the proposed design. (Note that the Component Performance option only addresses heat loss. However, glazing does also admit beneficial solar heat gain in the winter, provided that it is properly oriented and that there is adequate thermal mass to absorb the solar gains. Indeed, in this case, it is credit for these solar gains through the Energy Budget option that could allow this project to comply, provided there was adequate thermal mass.)

Opaque doors, conversely, are the smallest source of heat loss. However, this is one area where the heat loss through the proposed design (8.4) is less than that through the reference design (23.4).

For the proposed opaque wall, the heat loss (UA) through the perimeter edges of the floor slabs with R-5 insulation (102.4) is significant given how small this 1 foot wide band is on the two intermediate floors. However, this R-5 insulation is important. If this section was uninsulated (like portions of the bottom floor over the parking garage), the heat loss would be triple what it is. For the proposed metal stud walls, note that the U-factor of 0.065 for the metal stud wall with R-21 cavity insulation plus R-5 continuous insulated sheathing in the proposed design is roughly comparable to the U-0.062 in the reference design—the value of a wood stud wall with R-19 cavity insulation. This shows how steel studs provide a thermal bridge for heat to bypass the insulation and indicates how important continuous insulated sheathing is for reducing heat loss through metal framing. (While the heat loss through the proposed opaque wall (154.7 + 102.4 = 257.1) is less than that through the reference opaque wall (341.5), that is only because the glazing area is so large in the proposed design and thus the opaque wall area is smaller.)

For this project, skylights are comparable to opaque doors in that they are a small source of heat loss. Again, however, this is an area where the heat loss through the proposed design (25.0) is less than that through the reference design (32.6).

For the roof/ceiling, the proposed heat loss (190.1) is

10% higher than the reference heat loss (171.1). This is due to the steel trusses which act as thermal bridges through the insulation, allowing the heat to bypass the insulation.

Infiltration is not included in the UA calculations. However, the effective heat loss is significant (737.9) so careful attention should be paid to caulking and sealing. The greatest uncontrolled infiltration occurs with winter storms when there are strong winds and a high temperature difference between inside and outside. This is exactly the wrong time because it adds to the peak heating load. Better to have a well-sealed structure with ventilation that you can control.

Energy Budget

For the Energy Budget, the output shows that the Proposed 3.68 kW h/ft^2-yr is lower than the Reference 3.71 kWh/ft^2-yr. This is the reason that the program says "QUALIFIES for 1997 WA State Energy Code". Remember, however, that you must also check to see what the effective south facing glazing percent and whether there is adequate mass to store the solar gains.

DESPITE WHAT THE OUTPUT STATES, THE PROJECT DOES NOT COMPLY BECAUSE THE EFFECTIVE SOUTH FACING GLAZING PERCENT (Eff S Glz) EXCEEDS 8%, BUT THE MASS IS NOT ADEQUATE TO COMPLY WITH SECTION 402.1.4 OF THE ENERGY CODE.

The effective south-facing glazing is 9.9% of the floor area (see QUALIFY - Solar screen or the end of the "Compliance Documentation" report output). As the effective south-facing glazing exceeds 8%, Section 402.1.4 requires that there be mass in the building equivalent to 45 Btu/°F for each square foot of effective south-facing glazing. (This is to absorb the solar gains and prevent the space from overheating.) The effective south-facing glazing area is 1,426 square feet (9.9% of 14,400 square feet of gross conditioned floor area). Consequently, the minimum mass required is 64,152 Btu/°F (1,426 x 45). However, the proposed building only has 62,400 Btu/°F (= 48,000 + 14,400 from page 1 of the output, under the Proposed UA column).

In order to comply, additional mass would need to be added to the interior of the building. Consequently, it is necessary to add more mass in the "Additional Mass" field of the "QUALIFY-Component Performance" screen, and re-calculate.

DOCUMENTATION TO BE SUBMITTED

For this example, provide the following:

1. Indicate on drawings that space heating system type is gas and that all ductwork is inside the conditioned space.
2. Provide glazing and door schedules for vertical glazing (NFRC certified U-0.33 for sliding windows, NFRC certified U-0.35 for sliding doors, and default U-1.47 for garden windows), overhead glazing (default U-0.52 for skylights), and opaque doors (NFRC certified U-0.14 for opaque door). Provide manufacturer and model number, indicate NFRC certified U-factors where applicable and energy efficiency features where defaults are being used so that these can be verified by the field inspector.
3. Provide insulation R-values on all sections:
   - R-49 insulation in the ceiling,
   - R-21 cavity insulation plus R-5 continuous insulated sheathing in the metal stud walls,
   - R-5 insulation at the perimeter edges of the intermediate floors,
   - R-25 insulation above the bottom floor.
   - Provide WATTSUN "Compliance Documentation" report.
4. Provide WATTSUN "Compliance Documentation" report.
5. Provide supporting documentation for all entries with a double asterisk (**):
   - For R-49 ceiling insulation in steel truss, cite entry in Table 10-7A,
   - For R-21 plus R-5 metal stud wall insulation, cite entry in Table 10-5A,
   - For R-5 insulation at edges of floors, provide U-factor calculations,
   - For R-25 insulation above the bottom floor, cite entry in Table 10-4A,
   - For uninsulated portions of bottom floor, provide U-factor calculations.
6. Provide sunchart to justify assumption of "partially shaded".
7. Provide mass calculations to demonstrate compliance with Energy Code Section 402.1.4.

SAMPLE WATTSUN OUTPUT—page 1

```
WATTSUN 5.6        1997 WA STATE ENERGY CODE COMPLIANCE REPORT           03/17/99

FILE: C:\\WATTSUN5\\CAM412.WS                         HOUSE ID: CAM 412 Example

     Site: 1997 Solarview Drive                  Analyst:
           Seattle, WA  98101                Jurisdiction:
           (    )    -                           Utility:

Homeowner: Energy Backup, Seattle DCLU      House Type: Multi-family
           710 Second Avenue, Suite 200     Floor Area:  14400 ft2
           (206)684-7846

  Builder:                                Weather Data: Seattle, WA              ≥8
                                          Climate Zone: 1
           (    )

 The PROPOSED design *COMPLIES* with 1997 WA State Energy Code.

                                      REFERENCE          PROPOSED
 COMPONENT PERFORMANCE                 2141              2512  Btu/hr-F
 ENERGY BUDGET                         3.71              3.68  kWh/ft2-yr
```

DCLU address should print out here

Use this heated floor area in mass calculations on page 3 of Sample WATTSUN Output.

Contact information for person who did the WATTSUN analysis should print out here

To comply, value of "PROPOSED" must be lower than "REFERENCE" for either "Component Performance" (CP) or "Energy Budget" (EB). In this case, the project does not comply using the CP approach. This means it is necessary to check out the following features to see if it complies using the EB approach:
- **solar access**
- **effective south glazing & mass calculations**
- **heating system efficiency**

REFERENCE DESIGN

Component	Reference Value	X Area =	UA
Floor	U-0.041	4860	199.3
Glazing @15%	U-0.650	2112.0	1372.8
Doors	U-0.390	60.0	23.4
AG Wall	U-0.062	5508	341.5
Skylights @	U-0.680	48.0	32.6
Ceiling, Attic	U-0.036	4752	171.1
Infiltration	ACH-0.350	115200ft3	(737.9)
	Reference UA		2140.7

PROPOSED DESIGN COMPONENTS

Component	Description	Value	X Area =	UA
Floor	**R-25 continuous, conc.flr, T.10-4A	U-0.037	4380	162.1
	**uninsulated, 12 in. concrete floor	U-0.488	480	234.2
Glazing @32%	**NFRC Vin/LoE-0.10/Ar/Ins.sp. Sl.win	U-0.330	3790.0	1250.7
	**NFRC Vin/LoE-0.10/Ar/Ins.sp. Sl.dr.	U-0.350	720.0	252.0
	2gl wd/vin Ar + LoE Garden	U-1.470	90.0	132.3

****Provide supporting documentation for all components with a double asterisk.**

```
Items in parentheses not included in COMPONENT PERFORMANCE totals.
** Denotes non-standard values - check calculation of thermal value.
================================= Page 1 ==================================
```

SAMPLE WATTSUN OUTPUT—page 2

```
WATTSUN 5.6        1997 WA STATE ENERGY CODE COMPLIANCE REPORT          03/17/99

FILE: C:\\WATTSUNS\\CAM412.WS                              HOUSE ID: CAM 412 Example
```

Doors	**NFRC ins.metal w/tb in slab & frame	U-0.140	60.0	8.4
AG Wall	**R21 + R5, metal studs, Table 10-5A	U-0.065	2380	154.7
	**R5 edge of intermediate conc.floor	U-0.160	640	102.4
Skylights @	2gl Wd/V-clad Wd/V LoE .1+Ar	U-0.520	48.0	25.0
Ceiling	**R49 in 40' steel truss, Table 10-7A	U-0.040	4752	190.1
Infiltration	Standard Air Sealing	ACH-0.350	115200ft3	(737.9)
			Proposed UA	2511.8
Struc Mass	Slab w/carpet w/pad, Sheetrock wall	M- 5.000	9600	48000
	Light Frame, Sheetrock walls	M- 3.000	4800	14400

```
HEATING/COOLING/VENTILATING SYSTEMS

                                PROPOSED
      Heating System Type:   Gas Furnace
                    Make:    DEFAULT
         System Efficiency:          78 %
      Modified Efficiency:           72 %

                Design ACH:        0.60
   Design Load(at 44F dt):      171742 Btu/hr
  Duct Losses(% Dsn Load):           0 Btu/hr( 0%)
                Total Load:      171742 Btu/hr
      System Size(Output):      257500 Btu/hr (150%)

      Average Annual Heat:         262 MBtu
             Annual Cost:     $    1467

       Ventilation System:    Integrated Spot
                              & Whole House

           Cooling System:
                     SEER:          0.0 (Unducted)
  Cooling Load(at  4F dt):              Btu/hr
       System Size(%Over):              tons(@125%)
  Annual Cool Requirement:              kWh/yr

              Solar Access:     Partially Shaded

PROPOSED DUCT SYSTEM

                  Location              Avg Rvalue   Surface Area
    SUPPLY        All in heated space
    RETURN        All in heated space
```

Total proposed mass =
48000 + 14400 = 62400

Check this with required minimum mass on next page.

As "Partially Shaded" is claimed, sunchart must be submitted to verify that the site is unshaded for a minimum of 4-1/2 hours between 9 a.m. and 3 p.m. on December 21st.

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================================== Page 2 ==================================
```

SAMPLE WATTSUN OUTPUT—page 3

```
WATTSUN 5.6        1997 WA STATE ENERGY CODE COMPLIANCE REPORT        03/17/99

FILE: C:\\WATTSUN5\\CAM412.WS                          HOUSE ID: CAM 412 Example
```

GLAZING ORIENTATION

	PROPOSED		PROPOSED
South :	600.0ft2	North :	400.0ft2
Southeast :		Northwest :	
East :	1800.0	West :	1800.0
Northeast :		Southwest :	

Eff S Glz: 9.9%

In this case, effective south glazing is 8.0% or greater, therefore it is necessary to determine whether thermal mass complies with Energy Code Section 402.1.4 by checking inputs for structural mass and additional mass.

ENERGY CODE SECTION 402.1.4 COMPLIANCE CHECK

STEP 1: Calculate required minimum mass

Required minimum mass = 9.9% x 14400 sf x 45 = 64152

Effective south glazing percent from page 3 of Sample WATTSUN Output.

Heated floor area from page 1 of Sample WATTSUN Output.

Minimum mass required for each square foot of effective south glazing per Energy Code Section 402.1.4.

STEP 2: Compare with Proposed Mass

Proposed mass = 62400

Total from mass on page 2 of Sample WATTSUN Output.

CONCLUSION: **PROJECT DOES NOT COMPLY BECAUSE PROPOSED MASS IS NOT ADEQUATE for this glazing area.**

SUGGESTION: **Additional mass must be added or other improvements made before this project will comply.**

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Economic and energy consumption estimates are designed for comparative
purposes only.  Actual cost for heating will vary depending on weather
conditions, occupant lifestyle and other factors.
                                    Page 3
```